U. S. FOREST SERVICE

RESEARCH NOTE LS-58

LAKE STATES FOREST EXPERIMENT STATION • U. S. DEPARTMENT OF AGRICULTURE

Red Pine Needle Rust Disease in the Lake States

The needle rust (*Coleosporium asterum* (Diet.) Syd.) disease is widespread in the Lake States on young red pines. It is an inconspicuous disease that is easily observed for only 1 month (mostly June) of the year (fig. 1). It often kills the older needles, slowing growth and reducing Christmas tree values. Needle rust damage, when combined with insect injuries fatal to the new shoot, can kill young trees.

This Research Note summarizes conclusions from 3 years of research (Nicholls 1964). An article showing the experimental evidence is being prepared for publication in a technical scientific journal.

The Fungus and Its Hosts

Our observations, combined with a close study of the literature, suggest that there are at least three forms of needle rust in the Lake States. If there are several forms, this may explain the conflicting reports of host ranges in the literature (Hedgcock and Hunt 1922; Hedgcock 1916; Weir and Hubert 1916; Weir 1925).[1] Much more work will be required to clarify these host ranges.

The needle rust on red pine infects goldenrod, but not asters. Our inoculation tests have shown that jack pine and Austrian pine are also hosts to the red pine-goldenrod rust. The goldenrod we have most commonly used in our inoculation tests was *Solidago canadensis* L., but other goldenrods tested also became infected.

A second form, frequently found wild on bigleaf aster (*Aster macrophyllus* L.) has been successfully transmitted to cultivated annual asters, but it did not infect cultivated perennial asters or goldenrods. Its pine host remains unknown. The aster rust usually arrives late in the growing season, showing a few rare centers of infection that produce urediospores. These spread the rust rapidly over the Lake States, from aster to aster. A possible and intriguing explanation is that this is the western form of the rust (Hedgcock and Hunt 1922). It could be carried in by winds from the Western United States and overwinter occasionally on the rare, planted ponderosa pines of the Lake States. If this is Hedgcock and Hunt's western rust, then ponderosa pine would be a host. In 1962, ponderosa pines at Madison, Wis., were infected with needle rust, but none have been found since then — even when jack and red pines at the same site were heavily infected.

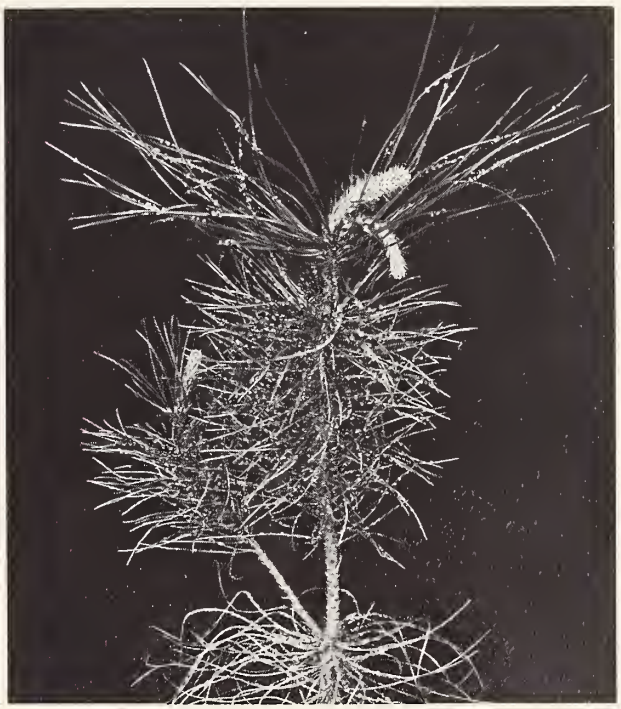

FIGURE 1. — Orange blisters on red pine needles in June are needle rust aecia. Three-year-old needles (bottom of picture) have the most blisters because they have been infected each year for 3 years. The fungus lives 3 years in the needle or until the needle dies.

[1] *Host range refers to the spectrum of plant species on which the fungus can grow.*

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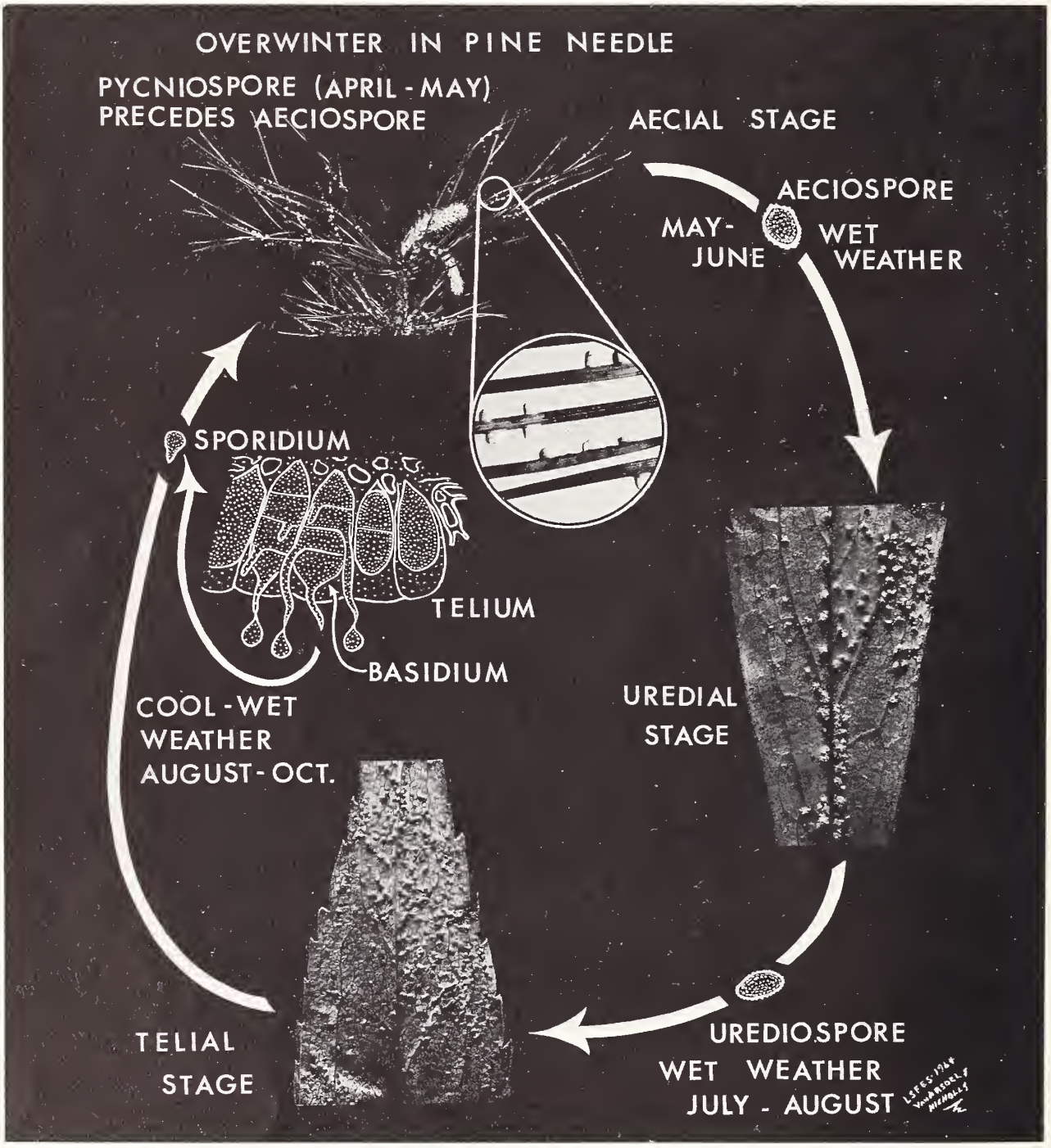

FIGURE 2. — Life cycle of *Coleosporium* on red pine and *Solidago canadensis* in the Lake States.

A third form of the rust was found in Madison, Wis., in 1961 on another species of goldenrod. This was successfully inoculated into perennial cultivated asters, but it would not infect annual cultivated asters. It infected certain goldenrods and certain asters, but not the same species that

were infected by the other two forms of the rust. No pine host is known.

Coleosporium asterum (Diet.) Syd. is the name of all three forms of the rust, according to the current interpretation of the botanical rules of nomenclature (Arthur and Cummins 1962).[2] The western form of the rust (an aster rust) has larger spores than the goldenrod rust, according to Hedgcock (1916), but our Lake States aster rust has smaller spores than our goldenrod rust. We have observed a color difference between aster rust (whiter) and goldenrod (darker orange) where both hosts were growing in the same environment in the Lake States. The shapes of the urediospores differ slightly.

In our descriptions of the life cycle, environmental influences, and control possibilities, we will discuss only the red pine-goldenrod rust, which is the only life cycle we have followed through to date.

Life Cycle

The red pine-goldenrod rust must live on both pines and goldenrods and go through five spore stages to complete its life cycle. This takes 1 year. The life cycle with environmental requirements is summarized in figure 2.

Frosty-orange pycnial droplets occur on pine needles at the onset of warm weather during April and May.

Aeciospores appear on pine needles a month later, after cross fertilization of the pycnia (fig. 3 *left*). Aecia are enclosed in flat-topped columnar blisters (fig. 3 *right*) that are conspicuous for about a month in May and June. These rupture under wet conditions, releasing the orange aeciospores into the wind, which carries them to the goldenrod leaves.

The uredial stage appears 10 to 15 days after aeciospores infect the goldenrod (fig. 4). From June to August, windborne orange urediospores infect other goldenrods.

Infection of goldenrod by both aeciospores and urediospores requires wet weather (dew and other moisture) for 20 to 25 hours.

Telia start forming on goldenrod while uredia are still present on the same leaves. In cool (60° to 68° F.) wet weather of late summer or fall, teliospores produce orange-yellow sporidia in 10 to 12 hours. These are carried by the wind to pine. Since freezing kills teliospores, pine infection must occur before frost.

Needle rust lives through the winter in red pine needles and repeats the cycle the following spring. Since the rust is perennial in needles and needles usually persist at least 3 years, the rust can easily survive 2 consecutive years of unfavorable weather for spreading.

[2] *Previously, the name approved by Arthur was* C. solidaginis *(Schw.) Thum. (Arthur 1934).*

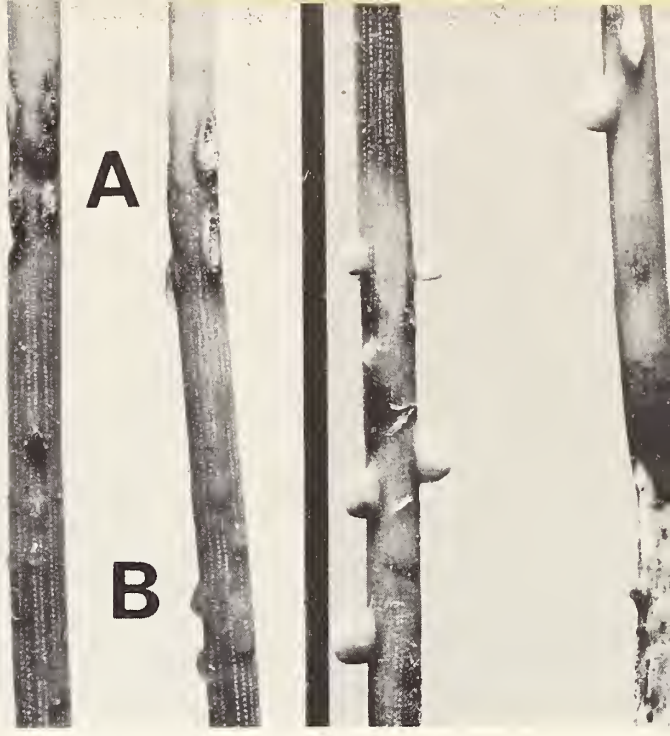

FIGURE 3. — *Left.* Two red pine needles at left show old aecial pits (A) and new pycnial droplets (B); the latter were produced by perennial growth of the fungus.
Right. Red pine needles with orange blisters containing aeciospores. Windborne aeciospores infect goldenrod under favorable conditions. Needle on right shows needle being killed by the fungus.

Possibilities of Control

Control of the disease is desirable in Christmas tree plantations and under conditions of severe infection. Four methods seem promising:

1. Preventing spore transport by —
   a. Avoiding planting sites with abundant goldenrods.
   b. Killing large concentrations of goldenrods in and adjacent to plantations with herbicides.
   c. Using plant barriers to change air currents between goldenrod and red pine as has been recommended for white pine blister rust (Van Arsdel 1961).
2. Protecting pines with fungicides during wet periods favorable to pine infection in late summer or fall. This is a promising method, but because of cost, it probably could only be applied in nurseries.
3. Reducing needle rust damage by avoiding microclimates that favor infection. Some applications follow:
   a. Herbicide applications in brushy, grassy, or weedy fields minimize local moist site conditions favoring infection, while killing alternate hosts. This elimination of brush competition also accelerates pine growth.

FIGURE 4. — *Solidago canadensis*, an important alternate host of the *Coleosporium* fungus. Inset shows a closer view of the uredia of the fungus.

b. Avoiding planting in small openings (diameter less than height of surrounding trees) keeps trees out of some of the areas that are wet and have much rust.

c. Also, avoiding any site where dew persists in the morning (such as west or north of a tree stand, on a steep west slope, or on or at the base of a steep north slope) reduces needle rust infection chances.

4. Selecting and breeding pines for resistance. This method is a possibility since some apparently resistant trees have been noted.

To summarize, useful control recommendations that we feel we can make with confidence are:

1. *Do not plant in small openings.*
2. *Do not plant just west or north of forest stands or bluffs.*
3. *Do not plant in brushy, weedy fields.*
4. *Kill brush and goldenrod in plantation areas with herbicides.*

Herbicide Recommendations

Some control of goldenrod can be obtained with 2,4-D spray on a hot, sticky day after the pine growth has hardened in late July or August. (Klingman and Shaw 1962).

Better control of goldenrod, brush, and grasses can be obtained in spring before widespread rust infection occurs. Use Dalapon, Amitrole, or Amizine when weeds are young, succulent, and actively growing.[3] General brush control is good with a 2,4-D and 2,4,5-T combination in early spring, but pine needles must be protected from spray.

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[3] *Personal communication. See Kuntz, J. E. Recommendations for weed control in forest plantations for the 1964 growing season. Wis. Conserv. Dept. Misc. Forestry Res. Rpt. 5. (Mimeographed.) 1964.*

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